IMPACT OF RIGID ENDOSCOPIC LARYNGOSCOPY ON ELECTROGLOTTOGRAPHIC AND ACOUSTIC PARAMETERS

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***Abstract:* Rigid high-speed laryngoscopy is the state of the art examination technique for the visualization of vocal fold dynamics. However, due to the insertion of the rigid endoscope in the oral cavity the voice production process including the dynamics of vocal fold vibrations becomes impaired. Therefore, the currently available computerized analysis procedures, which have been designed to enable a highly precise determination of vocal fold vibrations, measure vocal fold dynamics within an non-physiological condition. In this study the influence of rigid laryngoscopy on vocal fold dynamics and on the objectively derived voice measures are quantitatively investigated.**

***Keywords :* rigid laryngoscopy, vocal fold, laryngeal imaging**

I. INTRODUCTION

For the clinical examination of voice disorders rigid videostroboscopy is the most widely used examination technique to enable a visual inspection of vocal fold structure and dynamics. With the arise of modern larynx examination techniques such as kymography and high-speed imaging (HSI) a more accurate analysis of the underlying vocal fold vibration pattern became feasible. To derive a precise quantitative analysis diverse post processing procedures have been developed to extract vocal fold dynamics from the image data and quantify the degree of vibration symmetry and regularity [1].

One of these analysis and visualization procedures based on HSI is the computer based phonovibrogramm (PVG). It is able to visualize the entire oscillation pattern separated for each vocal fold within a single image (PVG). It was shown, that a highly precise quantification of vocal fold vibration parameters can be performed [2].

Mainly all results obtained from current analysis approaches base on rigid laryngoscopy. However, during rigid laryngoscopy the formerly undisturbed process of voice production becomes impaired because of at least two reasons: the insertion of the endoscope within the oral cavity and due to the holding of the protruded tongue by the examiner. By protruding the tongue the physiological position of the larynx is changed with the epiglottis into a more anterior superior position and thus putting the larynx with its vocal folds into a higher state of tense [3,4,5].

As a direct consequence quantitative measures, like e.g. PVG, derived from the endoscopic video data and likewise the acoustic signal do not reflect the normal, unimpaired physiological condition anymore.

In this study potential alterations of vocal fold vibrations induced by rigid laryngoscopy were investigated and quantified.

II. METHODS

Forty healthy subjects (20 females and 20 males) with untrained voices and no clinical history of voice disorders were examined during sustained phonation of the vowel /i/ at a comfortable frequency and intensity. The mean age of the female group was 41 (+/-13.1) years and 37.6 (+/-14.4) years for the male group. Each subject was examined twice.

Firstly, to derive information about the unimpaired condition vocal fold dynamics were examined using electroglottography (EGG) and acoustic recordings. EGG provides a relative measure of vocal fold closure without having equipment encumber the oral cavity [6]. EGG and acoustic data were captured using the Laryngograph® (Ltd., London, United Kingdom) system.

Following, a high-speed recording of vocal fold vibrations was performed by rigid laryngoscopy

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accompanied by a second recording of the EGG and acoustic signal reflecting the impaired voice production condition. The laryngoscopic video and acoustic data were recorded using the Endocam 5562 high-speed camera system, Wolf Corp., Knittlingen, Germany.

To detect alterations of vocal fold dynamics between the different examination situations a set of established parameters like fundamental frequency, jitter, shimmer and normalized noise energy (NNE) were computed from the EGG and acoustic data. Statistical analysis (Mann-Whitney-U-Test) was performed to identify potential significant changes between the different examination setups.

II. RESULTS

The results of the quantitative analysis of the acoustic and EGG data show that objective parameters representing vocal fold dynamics are significantly influenced by the examination situation. Firstly, during rigid endoscopic examination a significant increase of EGG detected fundamental frequency ($p<0.05$) could be identified. Average fundamental frequency was 179.67 Hz during the uninfluenced examination situation and increased to 225.72 Hz during rigid laryngoscopy reflecting a different (higher) muscular tension of the larynx. Fig. 1 further shows the change of the computed EGG-Jitter and acoustic NNE-values derived from the two examination situations. Significantly ($p<0.05$) increased values of Jitter and NNE prove an augmentation of vocal noise during rigid endoscopy. Average EGG-Jitter increased from 0.27 to 0.38%; NNE from -17.19 to -14.37. Accordingly, EGG-shimmer was significantly increased ($p<0.001$) during rigid laryngoscopy, rising from 1.85 to 3.55%. Fig. 2 displays the increase of perturbation measures in the shape of EGG-Shimmer (right) and fundamental frequency (left).

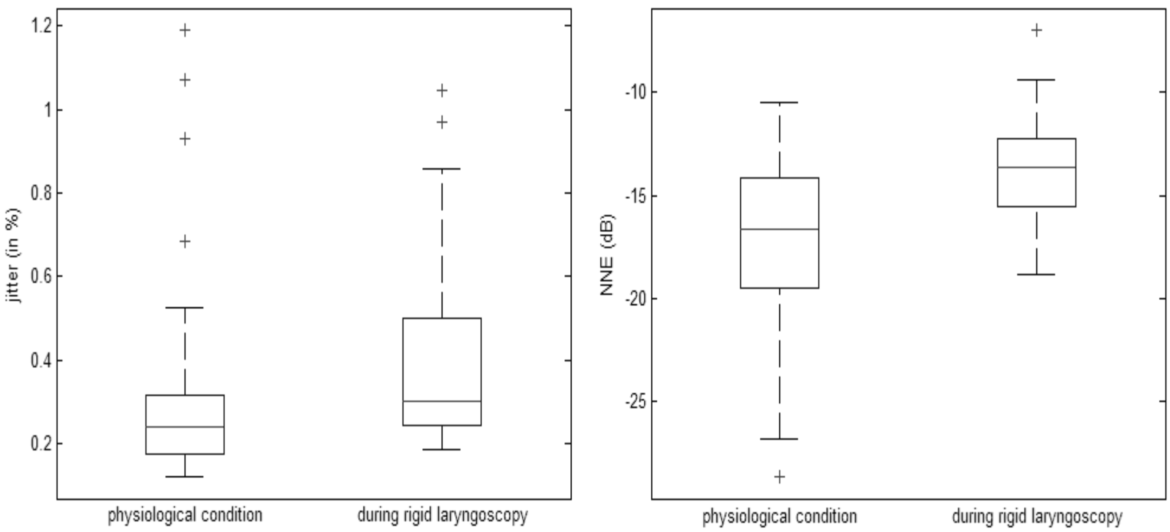

Fig. 1: Left: Boxplots of EGG-Jitter values obtained from the two different examination situations. Right: Boxplots of acoustic NNE values obtained from the two different examination situations. Both parameters are significantly increased as a result of the endoscopic examination.

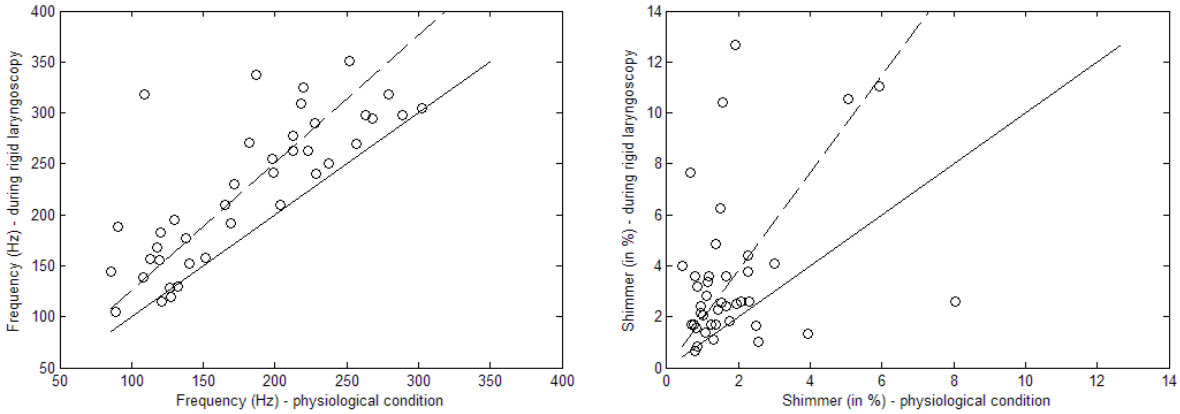

Fig. 2: Data obtained from the two different examination situations. The continuous line represents positions where parameters remain constant in both examinations. The dotted line has minimum distance to all measurements reflecting the averaged linear relationship of parameters from both examination situations. Left: Scatterplot of EGG computed fundamental frequency values. Right: Scatterplot of EGG computed shimmer values. Both parameters are significantly increased as a result of the endoscopic examination.

III. DISCUSSION

The results of the study demonstrate an increased irregularity and thus alteration of vocal fold vibrations induced by rigid laryngoscopy. The vibration pattern of vocal folds is hereby influenced by the inevitable change of the subjects' head position during the examination and by the endoscope within the oral cavity itself. Hence, when applying rigid laryngoscopy it has to be taken into mind that the examination situation itself influences significantly the dynamics of vocal folds. Particularly, when applying modern high-speed imaging systems which facilitate principally more detailed information about vocal fold vibrations it has to be considered that the obtained parameters are likewise altered during the non-physiological examination.

V. CONCLUSION

Objective parameters reflecting vocal fold dynamics and acoustic voice signals are significantly affected by rigid laryngoscopy. Rresults obtained from high-speed videos and rigid endoscopy reflect vocal fold dynamics within a non-physiological state. Hence, normative values about undisturbed vocal fold vibrations are methodically difficult to obtain. However, a combination of flexible endoscopy and high-speed imaging would improve the accuracy of vocal fold analysis procedures.

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